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Design

CATALOG D-122

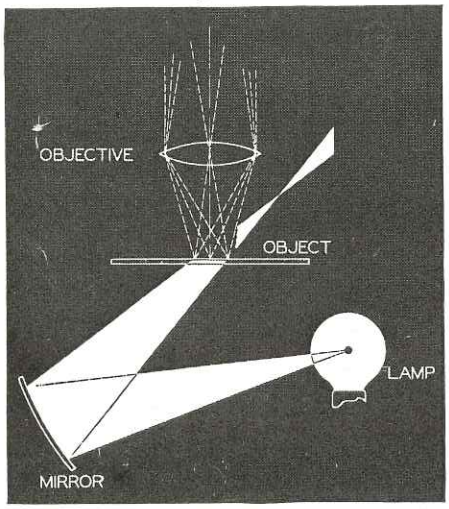
BAUSCH & LOMB
DARK FIELD OPTICAL SYSTEMS

DARK FIELD ILLUMINATION

with the Abbe Condenser

ILLUMINATION plays a very important part in all applications of the microscope. In the most common use of the microscope a strong beam of light is made to pass through the object. This is termed bright field microscopy, or microscopy in transmitted light. In order to be seen in bright field illumination, an object must absorb or refract the light passing through it so that contrast is set up between it and the surrounding medium. Objects displaying feeble contrast with respect to the background are very difficult to see in bright field illumination.

Figure 1



If such objects are illuminated by sending a strong beam of light through them, so directed that none of the direct light enters the microscope, they will appear self-luminous against a background of little or no light. This method of illuminating objects (where the objects appear self-luminous against a dark field) is called dark field illumination.

Dark field illumination can be secured in its simplest form by displacing the mirror of the microscope as shown in Figure 1 and allowing light from a frosted lamp to pass through the object from below, taking particular care that none of the direct light enters the microscope objective. Any object within this beam of light will reflect some light into the objective and be visible. This simple dark field setup produces illumination from one side, which would allow only two sides of the object located in this beam to be definitely visible. To avoid this condition, dark field condensers are made so that an annular ring of illumination comes to focus in the plane of the object and all sides of the object become equally luminous.

Dark Field with Abbe Condenser

A dark field may be produced by using the Abbe Condenser.

The numerical aperture of the illuminating cone of the Abbe Condenser, however, is relatively small, so that the value of this type of dark field illumination is limited to relatively large objects.

Dark Field Stop

Dark field illumination is obtained with the Abbe Condenser by inserting a Dark Field Stop in its lower focal plane (Figure 2). Most microscopes with substage condensers have an iris diaphragm below the condenser and a slotted ring for the purpose of introducing ground glass, blue glass and Dark Field Stops. Figure 2 shows the condenser with an opaque stop to cut out the central illumination and stop it from passing directly into the microscope objective. The light surrounding this stop passes through to the object in the form of a hollow cone.

It is essential always to use objectives whose numerical aperture is less than the lowest numerical aperture of the condenser. Objectives having higher numerical apertures would receive direct illumination from the condenser and the field would be bright.

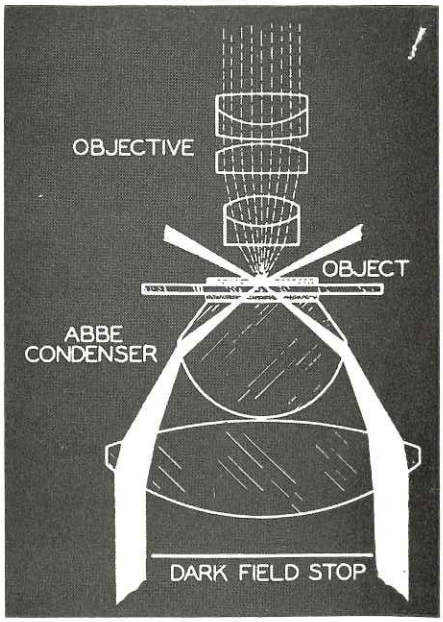
The 21× and 43× objectives are most suitable to use with this form of condenser. Lower power objectives, such as the 10×, 4× and 2×, have too large fields for the illumination furnished by the complete condenser. A dark field will be obtained with these latter objectives, but the size of field illuminated, and therefore the extent of objects visible, will be much smaller than the full field of these objectives.

The regular Abbe Condenser can also be used to furnish extremely good dark field illumination that will cover the field of a 10× objective and will nearly fill the fields of the 4× and 2× objectives, if the hemisphere, that is, the upper lens, is removed. The same Dark Field Stop should be left in the slotted ring and the condenser adjusted to give a brilliant, dark field illumination.

Applications of Abbe Condenser Dark Fields

Dark fields obtained with the Abbe Condenser are especially suitable for objects that do not require the highest magnifications to make them visible. Very beautiful views of the unicellular animals found in pond water can be obtained with this type of dark field illumination. Also, considerably more detail may be observed in small mounted insects or botanical specimens than is obtainable with ordinary bright field illumination.

Figure 2



U. S. Patent Office
AUG 19 1955
Design Division

DARK FIELD ILLUMINATION

with the Paraboloid Condenser

Paraboloid Condenser

THE Paraboloid Condenser is primarily designed to be used with high power oil immersion objectives and an intense illuminant.

A cross section of this Paraboloid Dark Field Condenser is shown in Figure 3. Parallel light passes by the opaque stop and is reflected at the parabolic surface out through the upper plano surface into the slide on which the object is mounted. The correct place for the object is the point where the light comes to focus. Light passes through this point under angles equal to numerical aperture from 1.24 to 1.33. The objective used with this condenser must have a numerical aperture less than 1.24. Best results will be secured if the objective aperture is not more than 1.00 N.A.

In using this condenser it is necessary that there be immersion oil between the condenser and the slide, since the angle of incidence of light on the surface of the slide is beyond the critical angle. Furthermore, it is necessary that the specimen to be illuminated be mounted in a liquid or cement and protected with a cover glass. Above the object it does not matter what kind of objective is used, that is, either dry or immersion, so long as the numerical aperture of the objective is not as great as the numerical aperture of the condenser. A standard achromatic objective 1.8mm, 1.25 N.A., with iris diaphragm for reducing the aperture, as may be required for dark field observations, is available.

For those who already have a standard 1.9mm, or 1.8mm, 1.25 N. A. objective, a funnel stop (No. 31-50-15) may be obtained for reducing the aperture.

For best results, the glass slide upon which the specimen is mounted should be from 1.45 to 1.6mm thick.

Applications of the Paraboloid Condenser

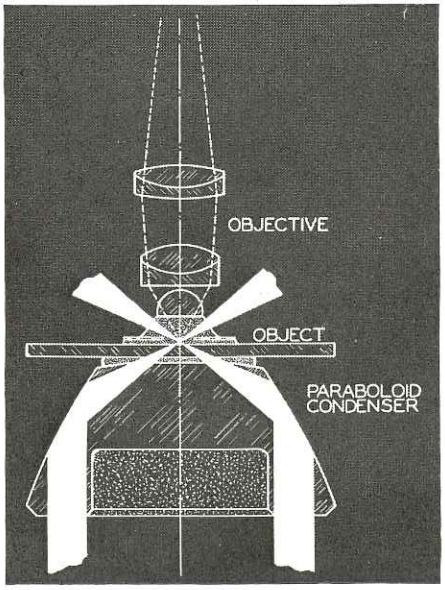
The illumination furnished by this condenser is most widely used in clinical laboratories for the examination of exudates from lesions in the search for specific organisms of the class Treponema pallida. It has been successfully used for the study of sera and exudates from thoracic and lung lesions. This provides a means of early diagnosis. It is also quite generally used for the examination of saliva, milk, blood, chyle, lymph, and pleural, pericardial and peritoneal fluids.

In industry the Paraboloid Condenser has many uses. In the dairy industry, motile organisms in milk can be seen with dark fields. It is useful in viewing transparent petrological preparations, as fine suspensions and inclusions in solid materials become quite visible. In studying dry powders, it reveals the microscopic structure of the particles. In the food industry this condenser is used for the study of mother liquors and fermentation of wines, vinegar, and molasses.

In bacteriological work, this condenser is used to recognize flagellated forms in unstained and living condition. It also has application in blood work on both stained and fresh material.

For teaching and demonstration purposes in biology and zoology, the Paraboloid Condenser reveals marked contrasts in protozoan groups. Cilia and flagella which have practically the same refractive index as the medium in which they are found, and might be overlooked in examination by transmitted light, are made visible.

Figure 3

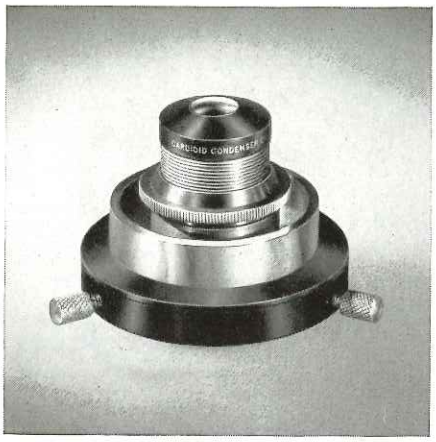


Paraboloid Condenser and Accessories

Specifications	*Catalog Number*	
Paraboloid Condenser including funnel stop, in centering mount for simple substage	31-58-50-21	
Paraboloid Condenser with funnel stop mounted on slide for research substage (no centering mount)	31-58-52-16	
Microscope slides, for Dark Field use 1.45 to 1.6	31-73-21	
Funnel Stop to fit oil immersion objective. Please describe objective, and give make	31-50-15	
Achromatic Objective, 1.8mm, 1.25 N.A., with iris diaphragm	31-10-72-02	

ULTRAMICROSCOPY

with the Cardioid Condenser



Cardioid Condenser

MANY things exist in nature too small to be seen with the microscope. Such things are said to be ultramicroscopic.

In the ordinary bright field microscope, Abbe has shown that resolution cannot be carried beyond a quarter-micron. Particles smaller than this, such as those existing in a colloidal solution, can be made visible by refined methods of dark field illumination.

The underlying principle of the visibility of ultramicroscopic particles is that, when illuminated by a strong beam of light, they deflect some of this light in all directions and thereby become luminous.

If enough of this deflected light is picked up by the eye or an optical instrument, the particles will appear as small discs of light, provided they are separated by distances resolvable by a microscope.

The Cardioid Condenser

The Cardioid Condenser represents the most refined form of Dark Field Illuminator. It is a reflecting condenser, being free from both spherical and chromatic aberration. A cross section of this condenser is shown in Figure 4.

This construction of the Cardioid Condenser, in which parallel rays are subjected to successive reflections from spherical surfaces, produces a cone of light whose rays are brought to a mathematically correct focus. This optical property will produce an exact image of an infinitesimally small surface in its conjugate focal plane, thereby making ultramicroscopic particles visible.

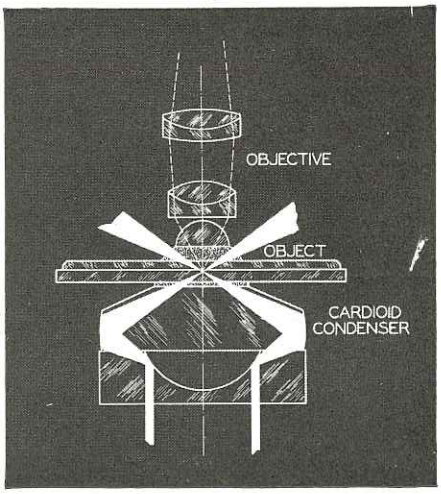
It is of utmost importance when using the Cardioid Condenser that the optical surfaces be kept clean and absolutely free from dust particles. Shillaber's Immersion Oil makes the cleaning easier because it can be readily wiped off with lens tissue and a very little solvent such as toluol. It is better than cedarwood oil in this respect and is, in addition-non-drying, non-fluorescing, color, less and has the proper refractive index for glass.

Applications of the Cardioid Condenser

In industry the Cardioid Condenser is very commonly used for the examination of flocculents of all sorts and liquid materials, especially in the paint and pigment industries. In the manufacture of edible and lubricating oils colloidal suspension may be examined and the microscopic structure of paraffin crystals observed.

The Cardioid Ultramicroscope is used extensively by colloid chemists. A small drop of liquid is ample for examination. In less than five minutes' time, this may be placed on the microscope and the state of subdivision determined. Conglomeration can be easily watched. Coagulation may be determined by counting particles at different intervals after adding a coagulant. The speed of Brownian movement may be used as a crude measure of the size of the particles. All well equipped chemical laboratories are most certain to find many opportunities for use of the Cardioid Condenser and its accessories.

Figure 4



Glass Slide

The slide should be clean and no thicker than 1.35mm. The material should be mounted wet and covered by a thin, clean cover glass.

Any conventional microscope objective can be used, if its numerical aperture is not more than 1.00 N.A. If the conventional oil immersion objective is used, it should be one with a funnel stop or an iris diaphragm.

Cardioid Condenser and Accessories

Specifications	*Catalog Number*	
Cardioid Condenser, in centering mount for simple substage	31-58-60	
Cardioid Condenser mounted on slide for research substage (no centering mount)	31-58-60-16	
Achromatic Objective, 1.8 mm, 1.25 N.A., with iris diaphragm	31-10-72-02	

31-58-51-51
Dark Field Illumination Unit
with non-centering adapter

DARK FIELD ILLUMINATION UNIT

THE physician or technician who finds it necessary frequently to change his microscope from bright to dark field or vice versa will appreciate the saving in time effected by use of the Bausch & Lomb Dark Field Illumination Unit. The Unit is similar to the Attachable Dark Field Illuminator except that the paraboloid condenser is permanently fixed to the lamphouse case in a non-centering mount.

Centering of the unit is effected at the factory. It is recommended that the Illumination Unit be ordered with the microscope if the latter is being purchased, thus permitting the Unit's centering to the oil immersion objective. In cases where it is desirable to purchase a Unit for a microscope already in the user's possession, the microscope should be returned to Bausch & Lomb to permit factory centering of the Illumination Unit to the microscope's objective.

ATTACHABLE DARK FIELD ILLUMINATOR

THE Attachable Dark Field Illuminator No. 31-33-43-61 is a compact, convenient light source of high intensity which was designed for use in dark field microscopy with the Bausch & Lomb Paraboloid Condenser.

This illuminator provides the most convenient source of illumination for this type of condenser and eliminates the necessity of using arrangements of separate illuminators and mirrors, each of which must be focused and adjusted. Since the Attachable Dark Field Illuminator screws into the adjustable centering mount of the condenser, it forms a permanently centered unit which cannot get out of adjustment accidentally.

Permanently Centered Lamp

The lamp is precentered at the factory. Being mounted in a special bayonet type base, with a locating slot engaging a pin on the illuminator house, the lamp may be replaced without disturbing the original centration. An achromatic condensing lens produces a beam of uniform intensity.

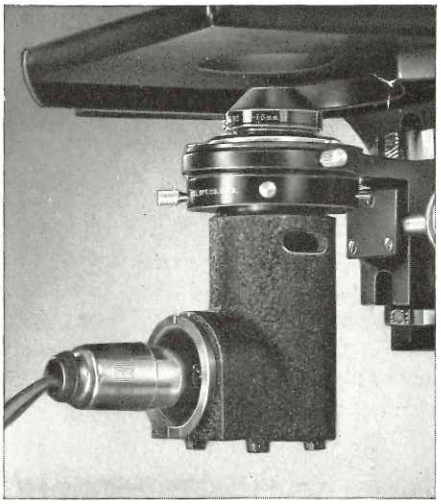
When the illuminator is attached to the condenser, there is sufficient space beneath the bottom of the illuminator house to allow for use of the substage focusing mount in compensating for variations in slide thickness.

Choice of Objectives

Either dry or oil immersion objectives may be used, so long as the numerical aperture of the objective is not as great as the numerical aperture of the condenser. It is possible to clean the immersion oil from the Paraboloid Condenser Lens without removing the unit from the substage.

The current supply can be a transformer or resistance for 115 volt alternating or direct current.

31-33-43-61 Dark Field Illuminator,
as used with the Paraboloid Condenser
in centering mount

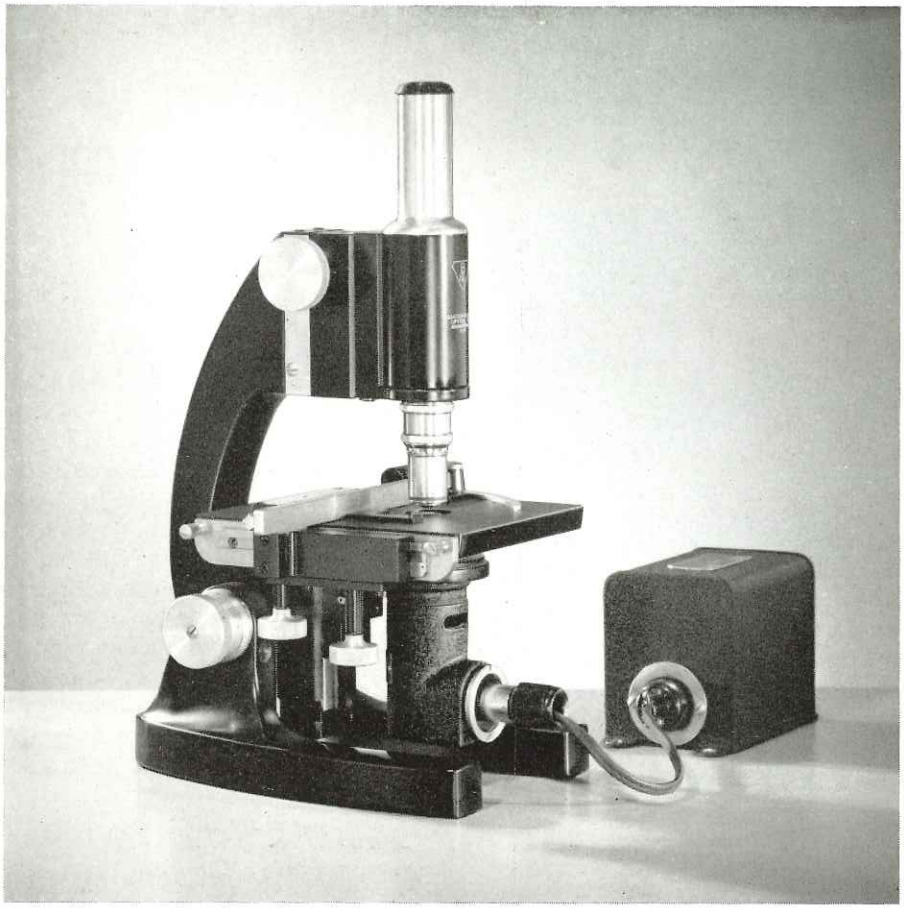


Specifications	*Catalog Number*
Attachable Dark Field Illuminator, for use with Paraboloid Condenser, with 6.5-volt, 25.5-c.p. lamp, dark field slide. Without transformer or resistance	31-33-43-31
Attachable Dark Field Illuminator, 31-33-43-31, above, and Paraboloid Condenser with funnel stop 31-50-15, in case. Without transformer or resistance	31-33-43-61
Dark Field Illumination Unit, consisting of Paraboloid Condenser in non-centering adapter for rack and pinion substage, and illuminator with 6.5 volt prefocused, precentered and preoriented lamp, and funnel stop 31-50-15 for 31-10-71 Achromatic Objective	31-58-51-51
Accessories and Replacements	
Transformer for 6.5-volt, 25.5-c.p. lamp on 115-volt A.C.	31-36-47
Adjustable Transformer for 115-volt A.C.	31-36-45
Resistance for 6.5-volt, 25.5-c.p. lamp on 115-volt D.C. or A.C.	31-36-44
Lamp, 6.5-volt, 25.5-c.p.	31-31-39

All of the above illuminators require a resistance or a transformer. Selection should be made according to the current available.

BAUSCH & LOMB DARK FIELD MICROSCOPE

with Paraboloid Condenser



31-20-33-61 Dark Field Microscope with Built-on Mechanical Stage

STANDARD equipment in every laboratory should include one or more Bausch & Lomb Dark Field Microscopes. The convenience and saving of time resulting from having an instrument reserved for dark field work are thoroughly appreciated. Another highly favorable feature of this specialized equipment is the fact that it permits successful dark field work without the necessity of advanced skill or training in centering the condenser and oil immersion objective. The centration is always accurately maintained.

Easily and Conveniently Operated

The objective, condenser, and lamp being in permanent alignment, all that is necessary for successful operation is to place on the stage a specimen slide, 1.45mm to 1.6mm thick, and effect oil contact between paraboloid condenser and slide and between slide and oil immersion objective. The Bausch & Lomb Dark Field Microscope has a focusing adjustment in its substage which permits the use of slides within the above limits of thickness.

The substage is moved up and down until a dark field giving best contrast between specimen and background is obtained. Another means of effecting adjustment for optimum contrast is furnished by the iris diaphragm in the oil immersion objective. Controlled by a knurled collar, the iris adjusts the numerical aperture between 1.25 and 0.50.

The Dark Field Illumination Unit, with precentered illuminator and color-corrected condenser, employs a 25.5 candlepower lamp, assuring intense light at the slide.

Specifications	*Catalog Number*	
Dark Field Microscope with built-on mechanical stage, 10× Huygenian eyepiece, Achromatic objective, 97×, 1.8mm, 1.25 N.A. with iris diaphragm, single nosepiece, dark field illumination unit, fixed transformer and wood case.....	31-20-30-61	

Specifications

Body Tube—Outside diameter, 39mm, blackened inside to prevent reflection.

Arm—Deep-curve, with ample room for manipulation.

Focusing Adjustments—Coarse, with rack and pinion. *Fine,* ball bearing and roller low position with head on each side of base. Right hand drum graduated to 1 micron in widely spaced stops.

Stage—Built-on Mechanical, accommodates up to 50 x 75mm slides.

Substage—Adjustable by rack and pinion and carrying Dark Field Illumination Unit with Paraboloid Condenser in non-centering adapter.

Objectives and Eyepieces—Regularly furnished with Achromatic Oil Immersion Objective, 97×, 1.8mm, 1.25 N.A., with iris diaphragm. Eyepiece, Huygenian, 10×. By substituting other objectives and eyepieces magnification can be altered.

Finish—Satin-smooth black, alcohol and reagent proof.

Case—Hardwood cabinet regularly supplied. Leatherette covered carrying case may be substituted at additional cost.

Transformer, fixed, for 115-V 60 cycle, A.C. (Resistance for 115-V D.C. may be substituted at no extra charge.

SUGGESTED DARK FIELD MICROSCOPES

For Paraboloid Observation

EQUIPMENT for use in diagnostic work in medicine, hematology, bacteriology, protozoology and other applications of dark field in biological work—instructional, routine, and research—is described on preceding page.

Paraboloid Microscope

Specifications	*Catalog Number*	
FBR Microscope Stand with single nosepiece, built-on mechanical stage, rack and pinion substage, mirror with fork, but without objectives, eyepieces, and condenser, in wood carrying case	31-20-30	
Paraboloid Condenser in centering mount (includes funnel stop)	31-58-50-21	
Huygenian Eyepiece, 10×	31-15-09	
Achromatic Objective, 16mm, 0.25 N.A., for use in centering Paraboloid	31-10-20-01	
Achromatic Objective, 1.8mm, 1.25 N. A., 97×, oil immersion, with iris diaphragm	31-10-72-02	
Microscope slides, 1.45 to 1.60mm thick	31-73-21	
Spherical Microscope Illuminator with Aspheric Condenser, 6 volt, 108 watt ribbon filament lamp, transformer for 115 volt, 60 cycle A.C., and blue and ground glass filters	31-33-78-04	
Metal baseboard to locate microscope and illuminator in proper relation	31-50-54	
Dark Field Illumination Unit, consisting of Paraboloid Condenser in non-centering adapter for rack and pinion substage and illuminator with 6.5 volt prefocused, precentered and preoriented lamp	31-58-51-51	
Lamp, 6.5 volt, 25.5 C.P. clear, in special adapter, prefocused, precentered, and preoriented for use in illuminator unit above	31-31-39	
Transformer, fixed secondary, 6.5 volt for 115 volt, 60 cycle A.C.	31-36-47	
Transformer, adjustable, 3-6.5 volt for 115 volt, 60 cycle A.C.	31-36-45	
Resistance for 6.5 volt, 25.5 C. P. lamp for 115 volt A.C. or D.C.	31-36-44	

Note: When ordering, please state kind of current and voltage.

For Cardioid Observation

The suggested Cardioid Microscope Equipment includes Balcoted* Apochromatic Objectives, Achromatic Objectives, Balcoted* Compensating Eyepieces, and the Mechanical Feed Arc Illuminator. These are recommended in securing the full benefit of the critical imagery possible with this refined dark field method. Glass slides and covers, properly selected as to thickness, are used with this microscope.

*Balcote is the Bausch & Lomb exclusive flare reducing treatment.

Cardioid Microscope

Specifications	*Catalog Number*	
FBR Microscope Stand, with single nosepiece, built-on mechanical stage, rack and pinion substage, mirror with fork, but without objectives, eyepieces, and condenser, in wood carrying case	31-20-30	
Cardioid Condenser, in centering mount	31-58-60	
Compensating Eyepiece, 7.5×, Balcoted	31-05-72	
Compensating Eyepiece, 15×, Balcoted	31-05-78	
Apochromatic Objective, Balcoted, 16mm, 0.30 N.A., 10×, dry, for use in centering Cardioid	31-11-71-01	
Apochromatic Objective, Balcoted, 4mm, 0.95 N.A., 45×, dry	31-11-81-01	
Achromatic Objective, 1.8mm, 1.25 N.A., 97×, oil immersion, with iris diaphragm	31-10-72-02	
Centering Nosepiece, tube part	31-19-11	
Centering Nosepiece, objective part	31-19-12	
Mechanical Feed Arc Illuminator, with inclinationjoint and on base adjustable for height, aspheric condenser. (Without resistance.)	31-33-81-02	
Resistance, 4.5 amperes for 115-volt D.C. for use with Mechanical Feed Arc Illuminator, plug and switch	42-46-52-	
Resistance, 8 amperes, for use with Mechanical Feed Arc Illuminator on 115-volt A.C., plug and switch	42-46-57-	
Fused Pyrex Water Cell, support and filter holder, for use with Mechanical Feed Arc Illuminator	31-34-24-25	

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When ordering, be sure to give catalog number and name of item.

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DESIGN CHANGES

Bausch & Lomb reserves the right to make changes in instrument design in accordance with scientific progress, and to supply apparatus resultingly different from that described or illustrated in its literature.

U. S. Patent Office
AUG 19 1955
Design Division

BAUSCH & LOMB OPTICAL CO

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